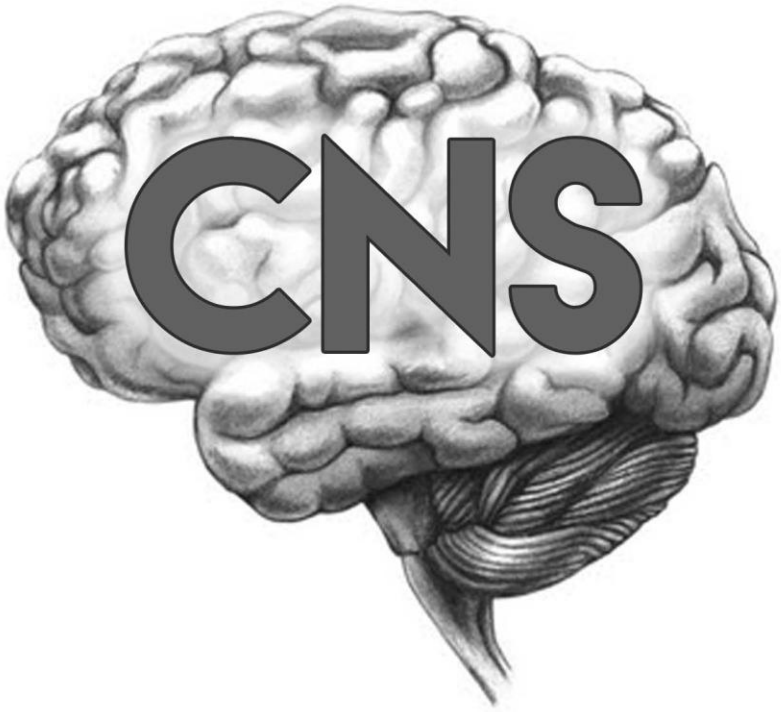


ANATOMY

☑ Sheet ○ Slide ○ Handout

Number

11

Subject

Basal Ganglia , Lab pics & spinal cord

Done By

NeveenAzzam

Corrected by

Abdallah S. S.

Doctor

Faraj Al-bustami

Date:

Price:

This sheet was written according to**Section 2** recording
https://www.dropbox.com/s/h9h7yj9gv6os4tg/%D9%81%D8%B1%D8%AC%2011.3ga?dl=0

The doctor emphasizes about the pictures, and said he will bring them in theoretical exam.

There is a lot of subjects in this sheetsome of them from the practical.., Have fun ..

ꕥ Contents : (handout 3 & 4)

- Basal Ganglia (BG)
- Functional Circuits
- Parkinson's disease: Clinical Signs, Chemical Changes & Treatment
- Athetosis&Hemiballism
- Gait disorders
- Brain sections
- Sensory System: Spinal Cord & Disc prolapse
- Dermatomes & Myotomes of the lower limb

* Basal Ganglia (BG) *

The INPUT for BG enters to Striatum; Putamen &Caudate.

The OUTPUT goes from Globus pallidus - internal segment (GP-i) back to the Cortex passing through the Thalamus.

- The input for the Striatum [could be Motor,, Association from frontal, parietal ...,, Limbic] reach GP-i by direct/indirect pathway.

Table 1

Direct pathway	**Indirect pathway**
Facilitates movements	Inhibits movements
Lesion = Less movement	Lesion = Excessive movements

Recently, it is found that some parts of the Cortex share the job with (help) BG (motor, premotor, SMA, association, limbic cortex/system).

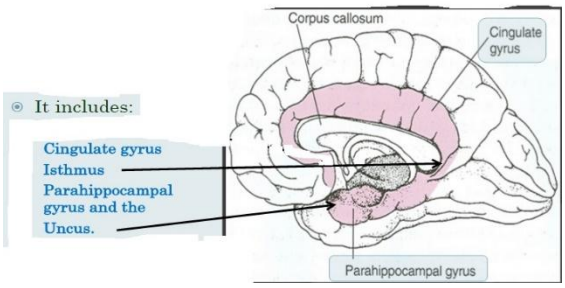
* Functional Circuits- Motor,, Association,, Limbic

 # General look:

Everything starts from the Cortex, the input signals enter the Striatum, by direct/indirect pathway signals reach GP-i, then the outputs go to Thalamus and finally back to the part of the Cortex that the process started from.

Limbic system - was previously known as the limbic lobe, consists of :

Cingulate gyrus (above corpus callosum) its posterior part = the Isthmus which continues inferiorly to Parahippocampal gyrus and Uncus



Hippocampal gyrus - it is part of the marginal cortex of parahippocampus that has been invaginated inward, so cannot be seen in midsagittal section since it is covered by parahippocampus, but it appears in coronal & horizontal sections.

• With coronal sections you can also see Amygdala- part of Caudate (BG)

The underlined parts are the 4 lobes of limbic lobe and there are other parts are included in the limbic system like parts of the Thalamus. ....

Table 2- Functional circuits

	Motor circuit	**Limbic circuit**	**Association circuit**
Cortex (Inputs source)	Primary motor, premotor, SMA, Primary somatosensory, Sensory association	Frontal association, Limbic lobe, Hippocampus, Amygdala	Association areas (frontal, parietal, temporal)
Striatum	Putamen	Nucleus accumbens$_1$ Ventral striatum	Caudate (mainly) Nucleus accumbens$_1$
GP-i	Via direct & indirect	direct & indirect	direct & indirect
Thalamus	VA -ventral anterior VL -ventral lateral	VP -ventral posterior DM -dorso medial	VA -ventral anterior Centromedial
Cortex	Motor cortex (premotor cortex)	- Anterior cingulate - Orbitofrontal (part of frontal association)	- Motor cortex - Prefrontal association - Wide cortical areas (to wake up the cortex)
Function	Movement defect = movement disorders see table 1	Regulation of emotions, motivations and affective aspects of behaviour	Cognitive function (Learning) Planning of complex motor activity

[1]Nucleus accumbens : the ventral part of the Striatum, where the head of the caudate & anterior of Putamen meet together // Union

Limbic circuit is important in motor expression of emotions (the posture, gesture and facial expressions related to the emotion) >disappear in Parkinson's (masked face)

"When a new task has been practiced and well learned, activity in the association circuit decreases and the motor circuit becomes active instead".

association التعلم بال والممارسة بال motor

•• What are the functions that BG participants in? What are the roles of BG??

Motor planning (its damage doesn't lead to paralysis or paresis)

Emotions, Motivation, Behaviour and Cognition.

℘ Parkinson's disease (revision to sheet 10)

*** Clinical Signs**

1- Hypokinesia or bradykinesia : the first clinical sign, means difficulty in the initiation, termination and even through movements - the patient had lost the decision to move (Hesitant to move)

2- Rigidity, cogwheel rigidity 

Table3 Rigidity VS Spasticity

Rigidity	**Spasticity**
BG defect	UMN lesion
NO !!	Hyperreflexia with paralysis or weakness and clonus could be seen And +vebabinski
Flexors AND extensors are affected (by hypertonia) (Bidirectional resistance)	Antigravity muscles are affected (Unidirectional resistance)

3- Rest tremors, pill-rolling (like he is counting pills or money) it a soft tremor type but sometimes it can be considerable (fade with movement)

Remember cerebellar tremor = intention tremors occur during the end of movement.

You can diagnose Parkinson's pt from his appearance!See the pic in sheet10

Stooped posture/ flexed attitude, his arms doesn't move or swing while walking, slow movement with **short shuffling gait** because of hypertonia **(Rigidity) which is the most disabling symptom,** expressionless face with staring look and rest tremor.

*** Chemical Changes**

Decrease dopamine/ acetylcholine ratio →decrease indopamine ,increase inacetylcholine

 # Treatment

L- Dopa :

Can cross BBB, and change into dopamine in **Living** dopaminergic neurons in **SubtantiaNigra**,, with time –like 2 years- these cells **die** the pt will come to you saying the drug is not working! The problem is not from the drug, the cell that was converting the drug has died, so replace the drug.

Is L- Dopa curative?? NO it is symptomatic drugCant prevent or stop the disease progress.

Anticholinergic drugs

From where Ach comes? (From the previous lecture) the **Striatum** has two types of cells ;
Cholinergic (excitatory) neurons : secretes ACh
GABAergic (inhibitory) neurons : secrets GABA
Cholinergic neurons receive inhibitory dopaminergic fibers inhibit them

In Parkinson disease there is no dopamine so there is no inhibition on the cholinergic neurons they will become hyper-excitable so excessive stimulation to indirect pathway neurons,,**indirect pathway will give signs of Parkinson**, So there is a need to block Ach function.

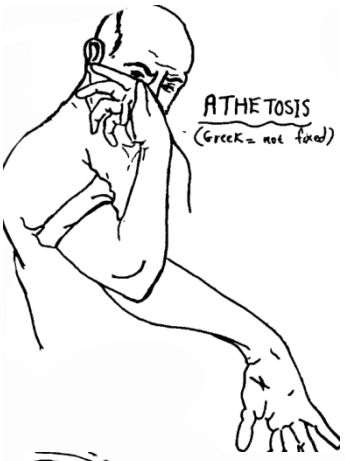
Amantadine,**stimulates the release of dopamine** from what's left of the substantial nigra and blocks Ach receptors (**anticholinergic effect)** **عصفورين بحجر.**

Hypokinesapt needs more L-Dopa **Tremor pt needs more Anticholinergic**

Surgical destruction of over active pallidum

* Other basal ganglia disorders result in Dyskinesia

(Dyskinesia = abnormal/disorder movements)

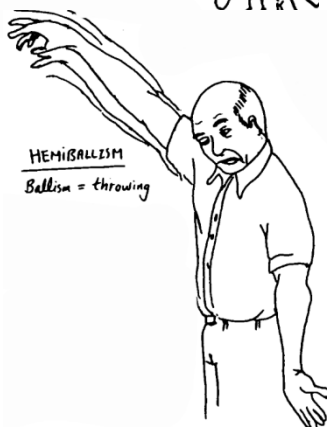


1- Athetosis

Injury in Putamen, it might be birth injuryby loss of blood supply to the brain. The pt will have slow snake-like involuntary movement of the extremities: continuous abductions and adductions with flexion and extension of different joints.

2- Hemiballism

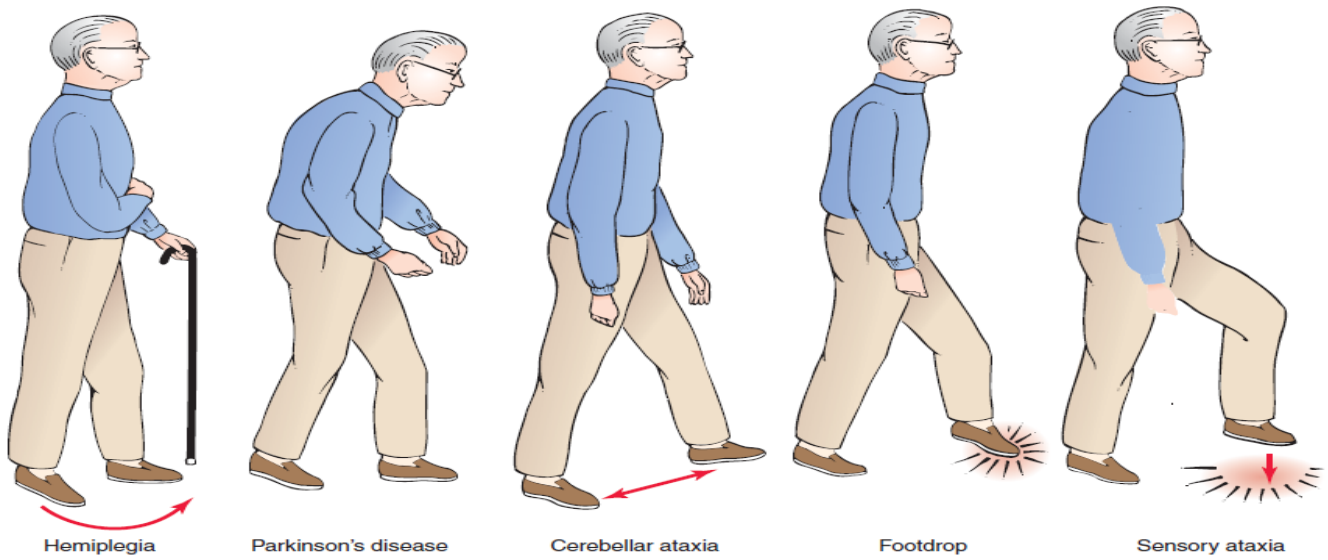
Injury in Subthalamic nucleus, the pt will show Violent abnormal movements (throwing) originating mainly from the proximal muscles



Symptoms are contralateral to the lesion, the pt has hypotonia and symptoms can released by surgical lesion in VL nucleus {wasn't mentioned}

You might think that the patients are mentally disturbed (schizophrenic) but no they have BG disorder!

*** Gait disorders**...deviation from normal walking



1)strok pt. he has hemiplegia with hypertonia in arm flexors and leg extensors.

Where is the lesion? Might be in cortex/ internal capsule/ brain stem/ spinal cord, anywhere before reaching alpha & gamma motoneurons ,, it is **UMN lesion**

There is paralysis or paresis, hyperreflexia, spasticity and hypertonia in antigravity muscles

2) Parkinson's pt. his arms doesn't move or swing while walking, short shuffling gait

Where is the lesion? the injury is mainly in substantia nigra in pars compacta causes decrease in Dopamine.

There is NO paralysis NO paresis, NO hyperreflexia, there is rigidity and hypertonia affecting flexors and the extensors. Table 3

Don't keep searching for hyperreflexia in Parkinson pt !!

3)Cerebellar Ataxia, The pt compensates the uncoordinated movements by **Wide-based gait,** he walks like drunken person to keep his balance.

The pt lost the unconscious proprioception and the muscle coordination

4) Foot drop, by damage to the **common peroneal nerve**

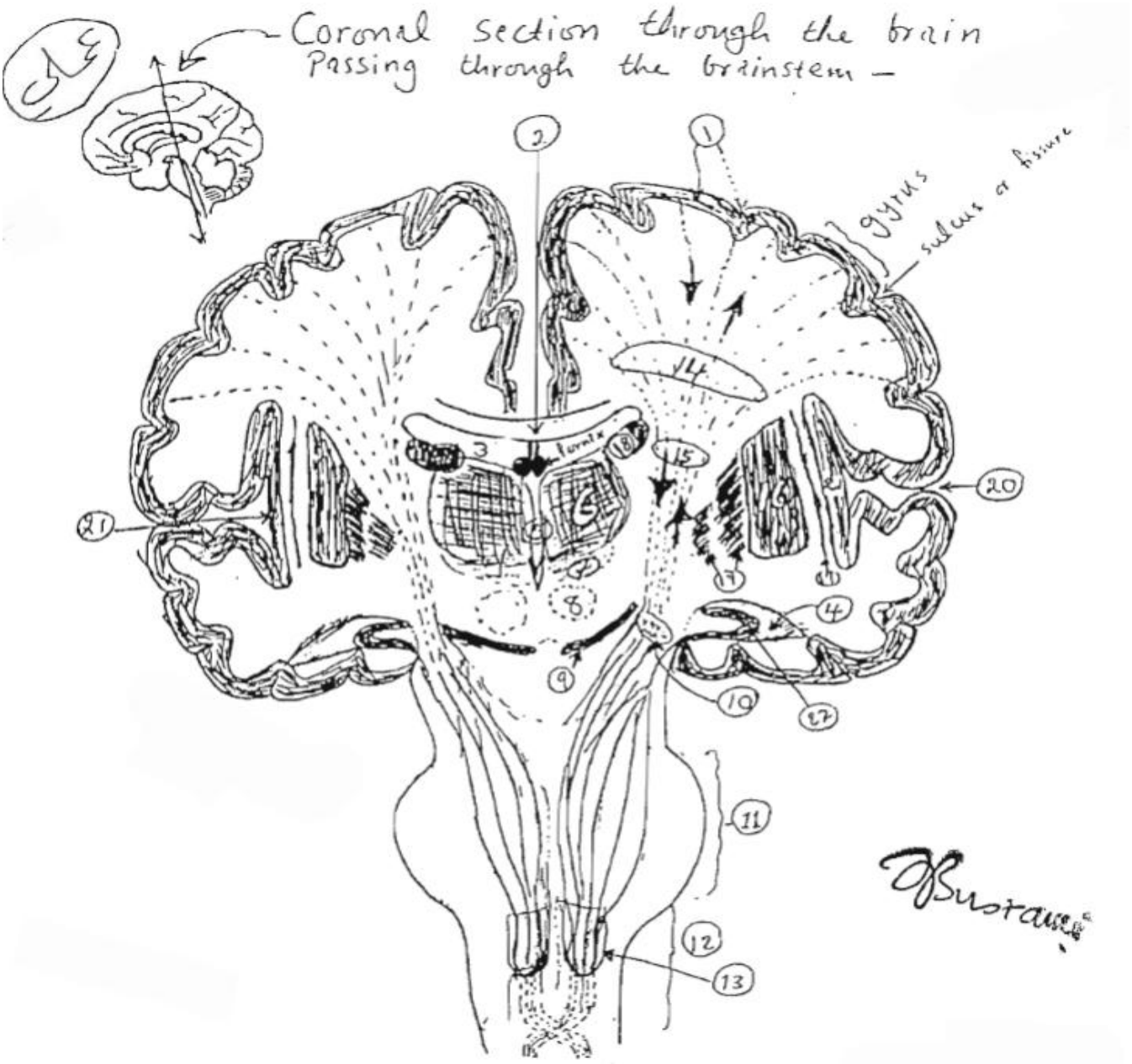
Do you remember the sciatic nerve? It terminates to 2 branches Tibial and Common peroneal. Common peroneal N. divide to superficial peroneal goes to the lateral compartment and deep peroneal to the anterior compartment (responsible of dorsiflexion).

So the injury to common peroneal, where dorsiflexion of the foot is compromised and planterflexion (by posterior compartment ms supplied by tebial nerve) is dominant, leads to foot drop with little inversion

5) Sensory Ataxia the pt lookslike he is measuring his steps; **Stomping gait,** when he descends his foot it hits the floor hardly ! He lost his conscious proprioception (sensation from muscles and joints)

* Brain sections *

* Coronal sections



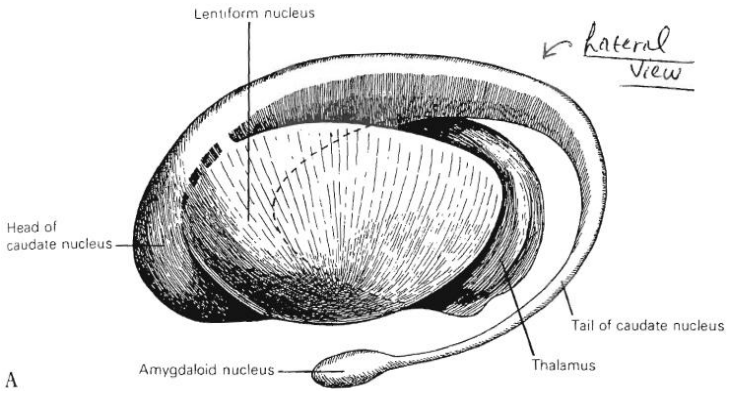
This **coronal** section shows the **parietal** (why not frontal?) **and temporal lobes, since it passes through Thalamus and Brain stem**

***** Above the lateral fissure (#20) you have Parietal lobe, beneath it→Temporal lobe

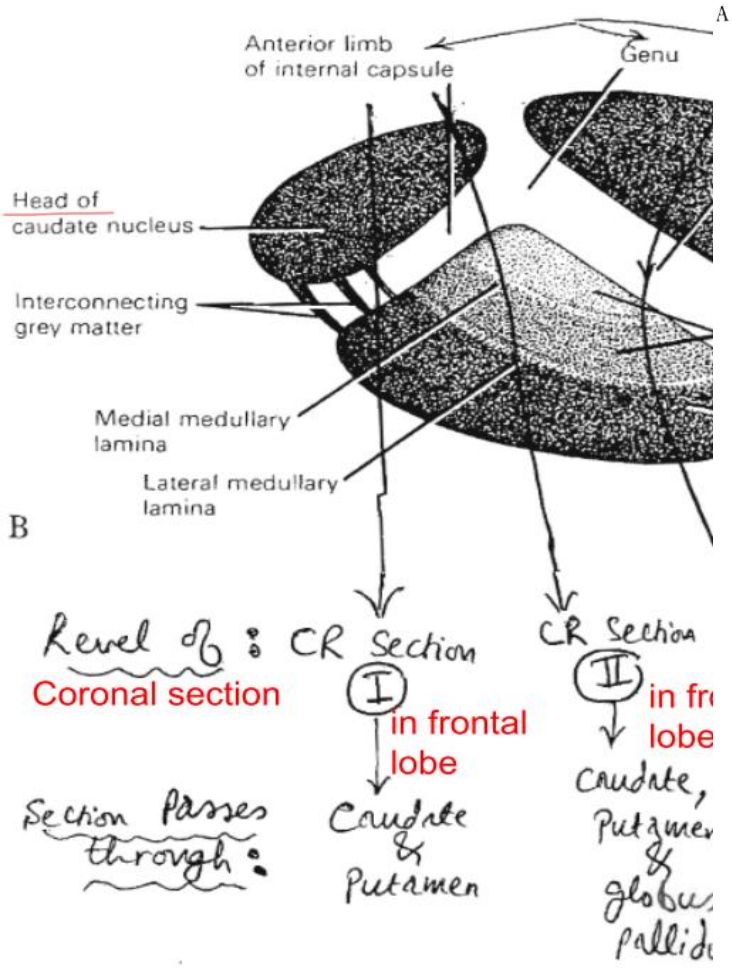
* Inside the lateral fissure (from lateral to medial) Insula, extreme capsule, claustrum, external capsule, putamen, globus pallidus external then internal, internal capsule, thalamus.

* Globus pallidus & Putamen = Lenticular (lentiform) nucleus.

** **Lentiform is lateral to the Internal capsule, while Thalamus and Caudate (head, body and tail) are medial to it.**

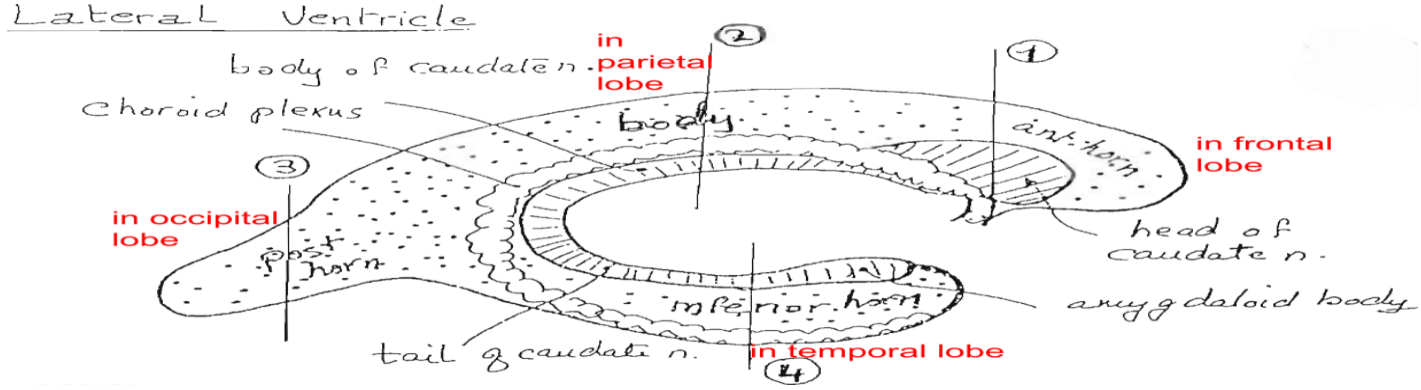


** **According to the level of the section you will have different structures**



* Every cerebral hemisphere there is a C-shaped cavity >>**Lateral ventricle**.

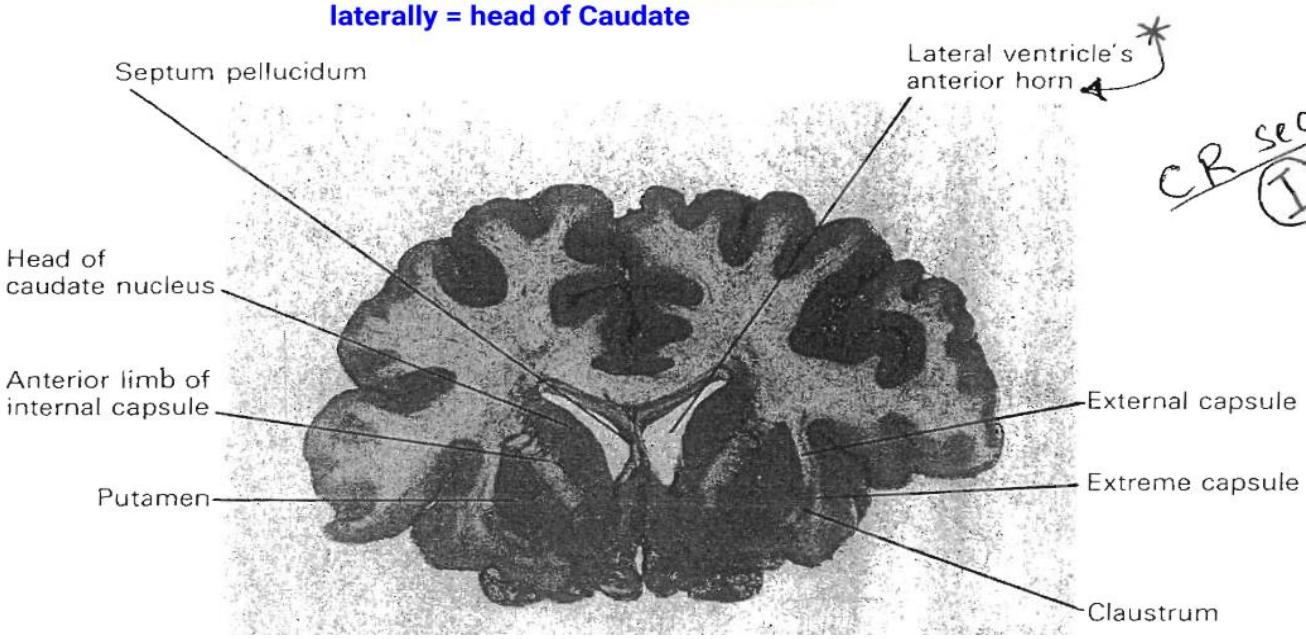
Has body and anterior, posterior, inferior horns. They can appear in coronal sections.



Coronal section #1
At the level of frontal lobe

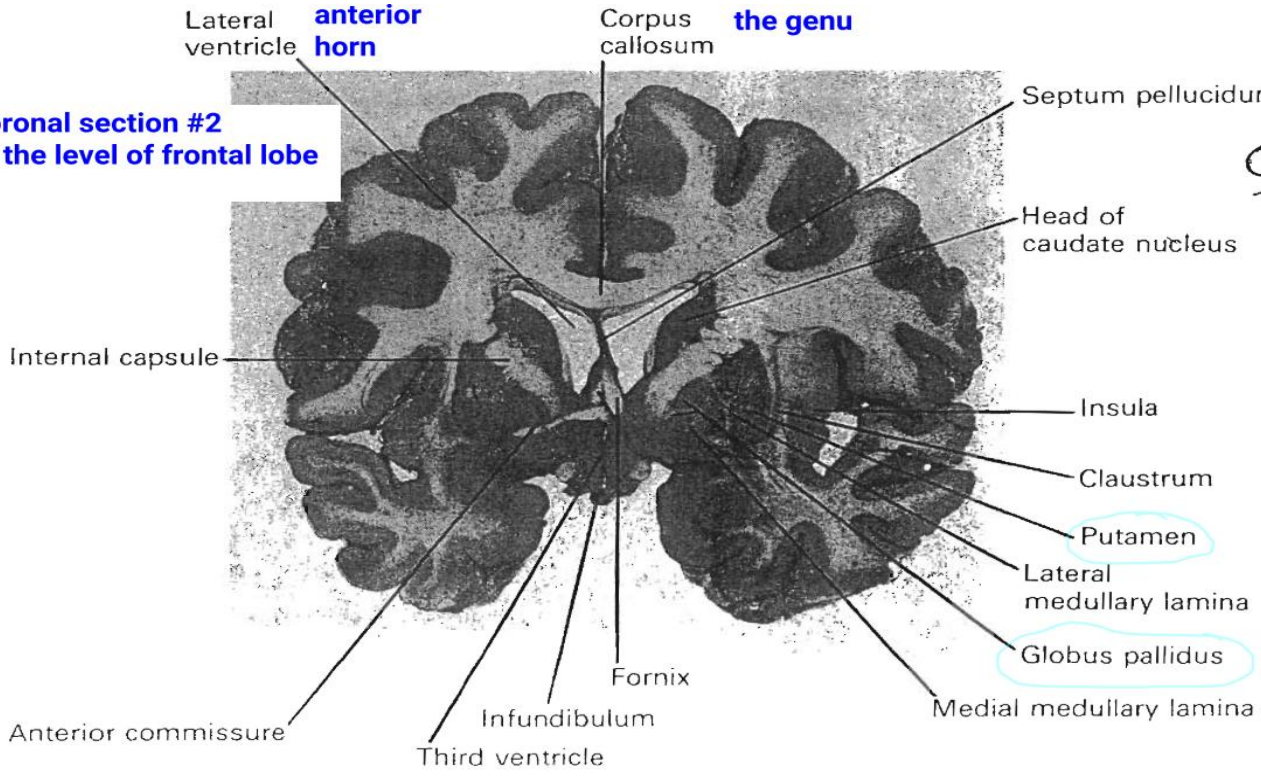
The cavity in frontal lobes is? the anterior horn of lateral ventricles
Anterior horn boundaries?

medially = Septum Pellucidum
superiorly = genu of corpus callosum
laterally = head of Caudate

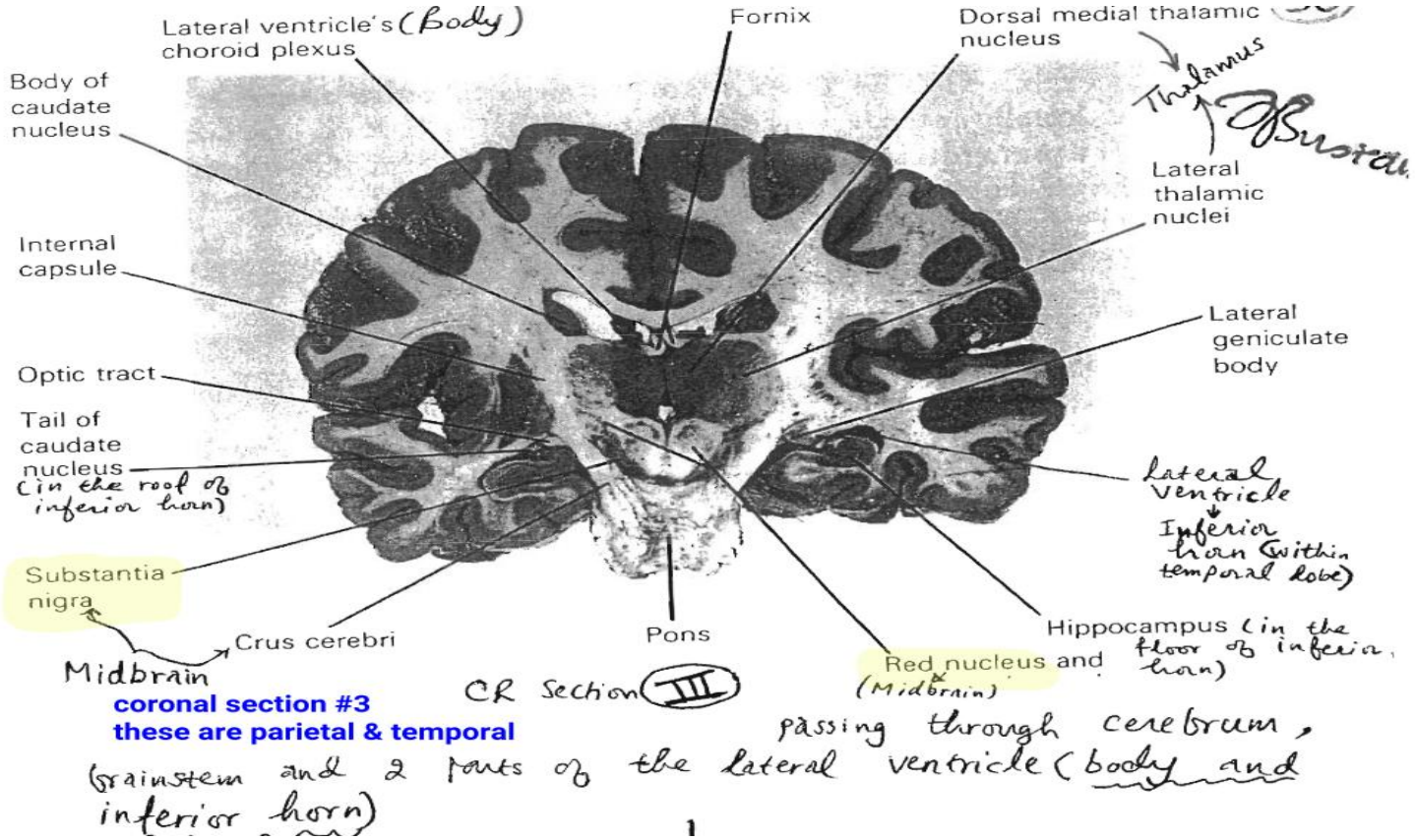


CR section I

Coronal section #2
At the level of frontal lobe



CR section II



This cavity is the BODY of lateral ventricle
above it = the BODY of corpus callosum
down to it (floor) = BODY of Caudate and Thalamus

Since the section passed through the Thalamus, definitely it will pass through Brain stem and the lobe above the lateral fissure is the Parietal lobe (NOT frontal).

Q: Identify the Red nucleus, and it's inputs. it receives inputs from :
the cortex >> cortico-rubro-spinal
the cerebellum >> dentato-rubro-thalamo-cortical

Q: Name the parts Substantia Nigra.
pars reticulata > has the same function and connection of GP-i
pars compacta > Dopamine synthesis

Q: Which is more ANTERIOR section 2 or section 3 ? 2

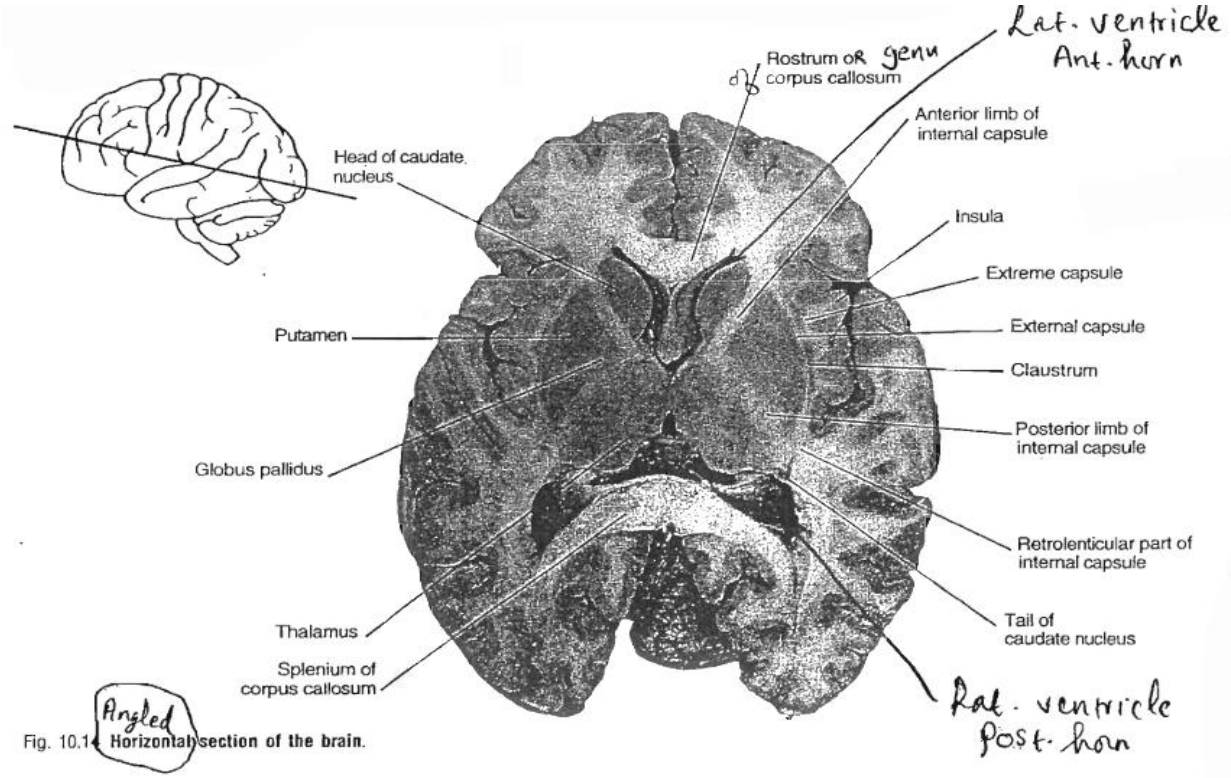
 # Note .. The **inferior horn of lateral ventricle** can be seen in Temporal lobe. There is a small cortical projection in the floor of this horn ((the**Hippocampus** gyrus)) while **Parahippocampal** gyrus stays in the inferior outer surface of the cortex. They are both parts of the limbic system.

Between the two Thalami there is the 3ed ventricle

The medulla has motor and sensory decussations.

* Horizontal section

This is the best adjustment I could do to this pic..



Angled horizontal section of Brain passing through CEREBRUM, basal ganglia, thalami, 2 parts of Lateral ventricle (ant. & post. horns), 2 parts of corpus callosum (genu & splenium)

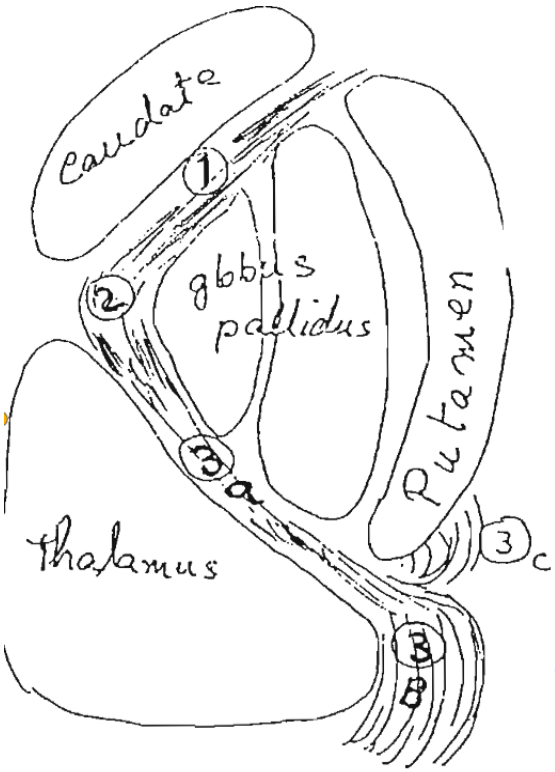
This is **angled** horizontal section, not sharp horizontal. It passes above the external ears and eye, why to use this! Because it is used in hospitals in CT scan التصوير المقطعي

If Caudate has #1 and Putamen has #2, the question will be..

What is the name of 1 & 2 together? Striatum

What is the type of signals that goes from 1 & 2 to Globus pallidus? Inhibitory-GABAergic

Internal Capsule parts, try to find them in the above pic



Internal Capsule

1 = Anterior limb
between the Cadate and Lentiform

3a = Posterior limb
between Thalamus and Lentiform

2 = Genu
At the angle

3b = Retro Lentiform part
behind the Lentiform

the 5th part = Sub Lentiform
we cannot see it, it is under the lentiform
here it 3c

---

* Sensory System *

* Spinal Cord

The spinal cord starts at Foramen Magnum as a continuation of Medulla, and ends at the lower border of 1st lumber vertebrae (at level L1/ L2).

Its length is 25 cm, and it's **shorter** than the vertebral column. **It doesn't fill the whole vertebral column just upper two thirds!**

What fill the other third?
The sensory and motor roots of Lumber & Sacral nervesknown as Cauda Equinaذيل الحصان

This is the spinal segment ;

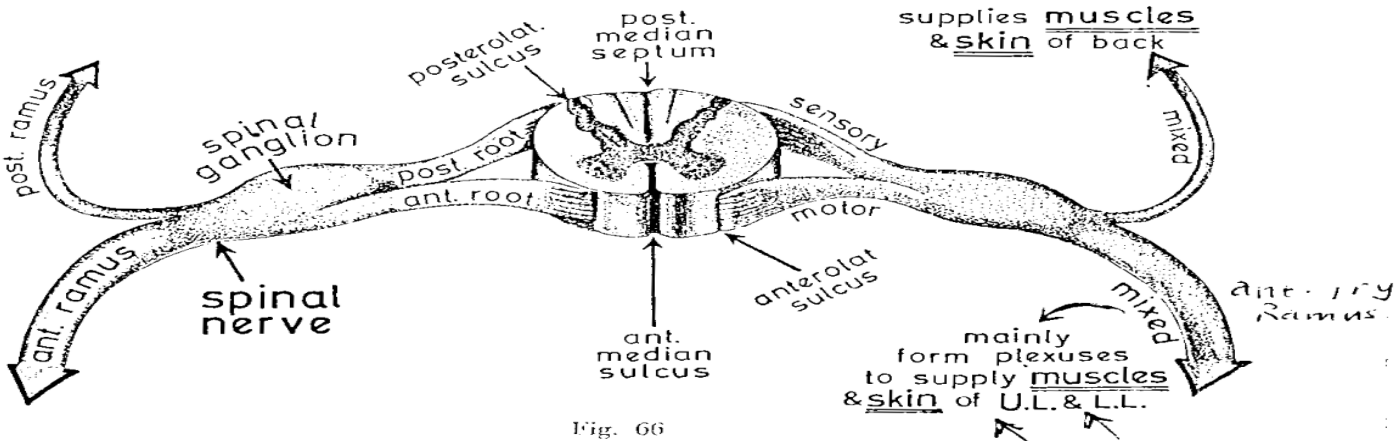


Fig. 66

We have 31 spinal cord segments and 31 pair of spinal nerves

Each spinal nerve has a dorsal/sensory root and ventral/motor root

Table 4

Region	**# of Spinal segment = # of Spinal nerves**	**Vertebrae no.**
Cervical	8	7
Thoracic	12	12
Lumber	5	5
Sacral	5	5

***** The segments of the spinal cord are not in line with the corresponded vertebrae and the difference increases as we go downward.**

The segment precedes its corresponded vertebrae, since the spinal column is shorter than the vertebral canal.

So what is inside L1/L2 vertebrae? The end of the spinal cord (sacral segments)

Where are the lumber segments L1 - L5? In T10- T12

spinous process of C6 is opposite the spinal cord segment C7

spinous process of T3 is opposite the spinal cord segment T5

spinous process of T9 is opposite the spinal cord segment T11.

Spinous process (Vertebra)	Spinal cord segment
C6	C_7
T_3	T_5
T_8	T_{10}
$T_{10} - T_{12}$ $L_1 - L_2$	$L_1 - L_5$ S_1 – end

***** What keeps the spinal cord in its position?**

1) Filumterminale

A filament of connective tissue made by glial cells that extends from the apex of the conusmedullaris and is attached to coccyx.

2) Denticulate ligaments

In both sides, formed from Pia mater and are attached to the Dura mater

3) The Dura mater

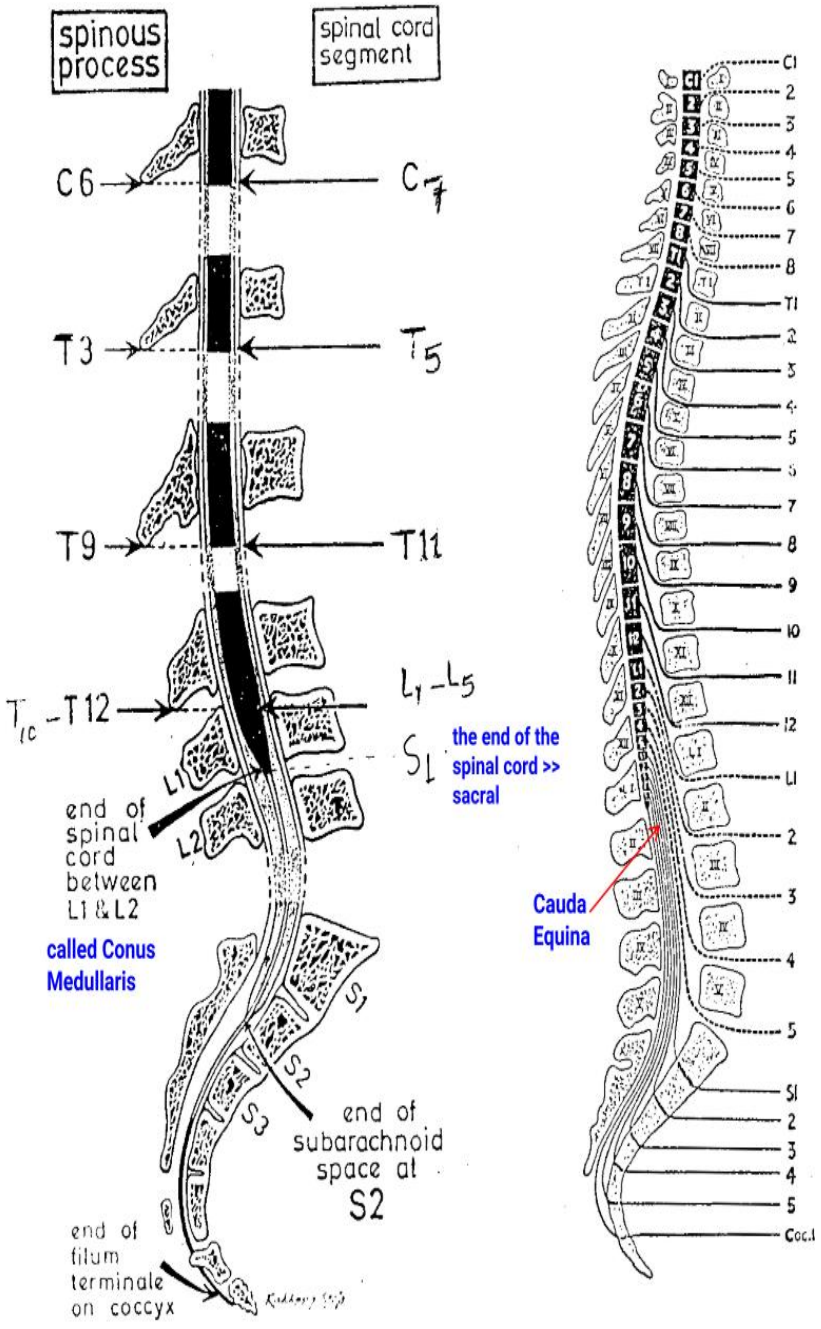
It is attached to foramen magnum above and to the margins of the intervertebral foramina.

***** The lower the segment of the spinal cord, the longer the distance which the roots have to descend. The roots increase in length as you go downward.**

جذور الاعصاب تزداد طولا من اعلى الى اسفل

**** Every spinal nerve emerges from the spinal column through the intervertebral foramen (an opening between adjacent vertebrae) UNDER its corresponding vertebra and in the UPPER part of the foramen.**

This is true for all spinal nerves except for thecervicals,they are 8 nerves and have 7 vertebrae, so first 7 cervical nerves pass ABOVE their corresponding vertebrae and the 8th pass under the 7th vertebra.



* Disc prolapse

The intervertebral disc is an example of secondary cartilaginous joint.

Every disc is consist of Nucleus Pulposus (soft part) surrounded by Annulus Fibrosis.

In disc prolapse there is a tearing in Annulus Fibrosis that allows the soft Nucleus Pulposus to bulge out and compress the spinal cord (in case it happened in cervical region) or spinal nerve roots (in Lumber region) behind.

 # Again, (Every) spinal nerve emerges under the vertebra with the same number, the opening between L4 and L5..The nerve that will emerge from here is? L4

 # The nerve will EXIT at the UPPER part of the intervertebral foramen, so if the disc prolapse it WON'T compress it,

If L4/L5 disc get prolapsed >> L4 spinal nerve exit at the upper part of the foramen leaving L5 behind it in the vertebral column facing the situation,

So L4 spinal nerve will not be compressed while L5 spinal nerve will be compressed by the Nucleus pulposus and the pain & weakness will relate to L5 dermatome(if dorsal root was compressed) and myotome (if the ventral root was compressed).

**** The commonest disc prolapse happens to L5/S1 disc then to L4/L5 disc**.

•☆ If a pt came to you complaining from an old lower back pain {disc prolapse in L4/L5} and new loss in sensation in the big toe, don't diagnose him with diabetic neuropathy! It's too obvious the disc is compressing on the toe nerve (L5)..

If the compression wasn't that powerful you will feel the pain in the skin, but if it was and the nerve is damaged you won't feel any sensation from its supplied areas.

* Dermatomes & Myotomes of the lower limb

The dermatome is an area of the skin that is supplied by a single spinal nerve.

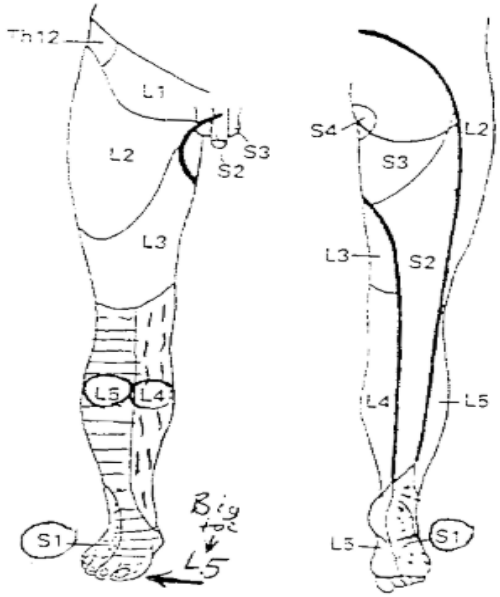
Compression of the motor roots of the spinal nerves = **LMN lesion** {alpha and gamma lesion}

Most Common Lumbar Disc Syndromes

Root	Disc interspace	Reflex Affected	Motor Weakness	Sensory Changes (if any)
L4	L3–L4	Knee jerk	Knee extension	Anteromedial leg
L5	L4–L5	Hamstring jerk	Large toe dorsiflexion	Large toe, Anterolateral leg
S1	L5–S1	Ankle jerk	Foot, plantar flexion	Foot, lateral border

The Dr read every single word of this page

Dermatomes of lower limb



Myotomes of lower limb

L2, L3, L4 → quadriceps → Knee extension
Iliopsoas → thigh on hip flexion
adductor group → thigh adduction

L5 → Tibialis anterior / Extensor hallucis longus } Ankle & big toe DORSIFLEXION
hamstring
[Check: have patient walk on heels]

S1 → gastrocnemius → Ankle Plantar-flexion
[Check: have patient walk on tiptoes]

•☆ **If you suspect a disc prolapse that compresses on S1**, how to examine this? Tell the pt to walk on his toes! S1 supplies Gastrocnemius which acts on the ankle joint and causes Planter Flexion of the foot.

•☆ **If you suspect a disc prolapse that compresses on L5,** how to examine this? Tell the pt to walk on his heels! L5 supplies the muscles that cause DorsiFlexion of the foot.

The End !!

I wish you the best of luck

Neveen Azzam